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VIRESCENCE OF OXALIS STRICTA.

BY HENRI HUS.

Specimens of *Oxalis stricta** with bright green petals were for the first time observed in the early part of September, 1906, in the immediate vicinity of St. Louis, in an unused portion of Bellefontaine Cemetery, not far from Florissant Avenue, which skirts its southeastern boundary. For the sake of convenience these plants are designated as *Oxalis stricta viridiflora*. Their discovery was entirely accidental, for the plants were few in number, certainly not more than twelve. Interspersed with normal plants of *Oxalis stricta* and grasses, they formed a patch not larger than eight square feet. The spot was revisited several times during the fall of the same year and during 1907. Specimens gathered on these trips as well as plants raised this year from seed collected last fall, yielded the material on which this paper is based.

With the exception of the petals and perhaps of the fruit, the plant agrees in all respects with the published descriptions of *Oxalis stricta* L. The plants are equally vigorous, but both flowers and fruit are smaller. The average length of 100 nearly ripe fruits of *O. stricta* collected in the vicinity of St. Louis, was found to be 17 mm.; the average length of 100 petals of the species collected in the same neighborhood and in spring was 8 mm., of the same number, from the same locality but collected in fall 6 mm. The same measurements made on parts of *Oxalis stricta viridiflora*, yielded respectively 12, 6 and 5 mm.

A microscopical examination of petals and sepals of the species and its variety overthrew a preconceived notion as to their minute structure, an opinion based on studies of *Epilobium hirsutum cruciatum*, *Oenothera Lamarckiana cruciata* and others.† It was expected that since the petals had assumed the color of the sepals, even though not the form, they would likewise have acquired other characters which particularly distinguish the sepals.

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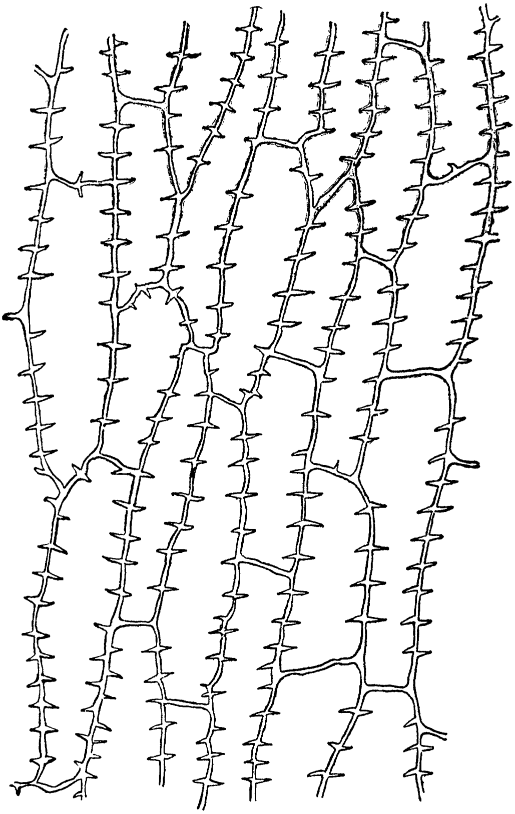
* This is *Oxalis stricta* as represented in the Linnaean Herbarium, according to Small (Bull. Torr. Club. **23** : 267) and Robinson (Jour. Bot. **44** : 386), though not of most English and American writers. It is the *O. corniculata Dillenii* of Trelease in Syn. Fl. N. Am. **1**^{1} : 365.

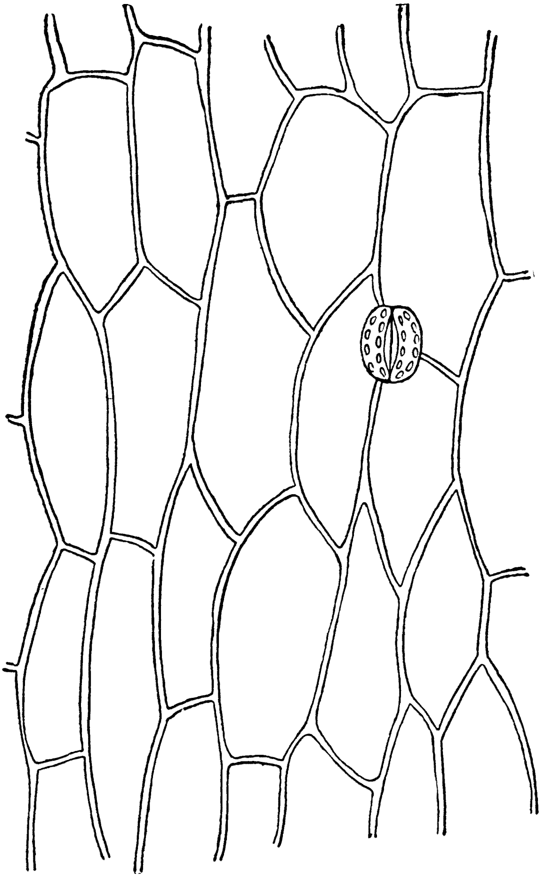
† De Vries, Hugo. Die Mutationstheorie. **2** : 593.

The normal petal of *Oxalis stricta* is yellow and obovate, with a more or less undulate margin. It is frequently slightly notched at the top. The vascular bundles branch and spread like the sticks of a fan, adapting themselves to the outline of the petal. The exterior surface, seen under a low power, shows nothing but the distribution of the vascular bundles and the presence of a few hairs near the tip. These hairs, on greater magnification, are shown to be of two kinds, the one



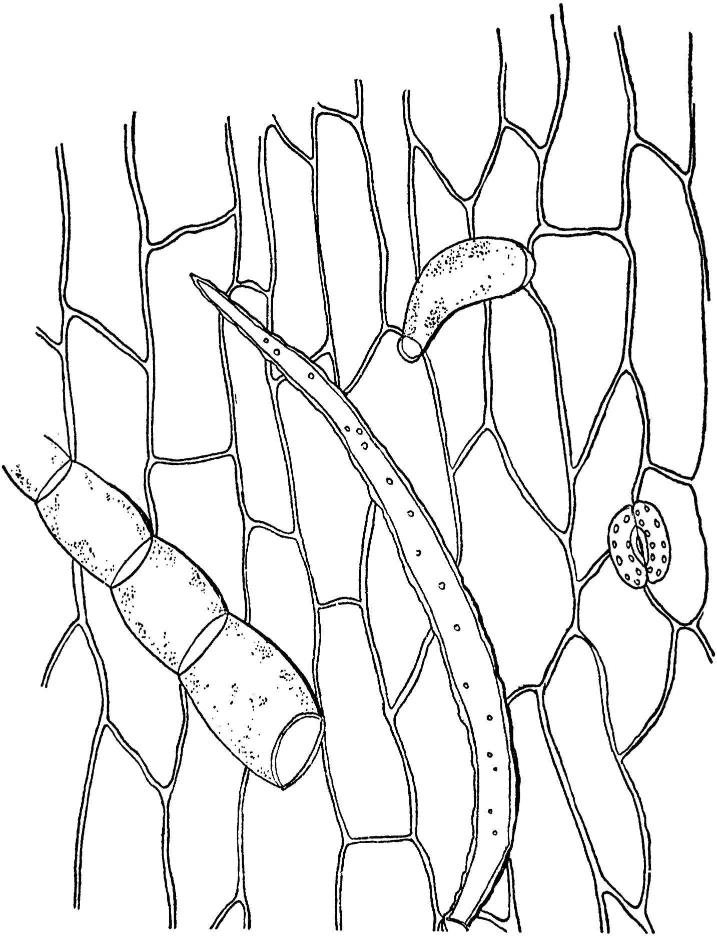
1. NORMAL PETAL, NEAR TIP, × 400.

pluricellular and thin-walled, the other unicellular, with thicker walls covered by numerous wart-like projections. The cells of the epidermal layer of the petal are longer than broad and possess projecting ridges (fig. 1). They are prolonged into blunt papillae. Epidermal cells with smooth walls are found near the base and especially in the neighbourhood of the vascular bundles (fig. 2). Occasionally a stoma is seen. The interior surface of the petal does not really differ from the exterior surface.



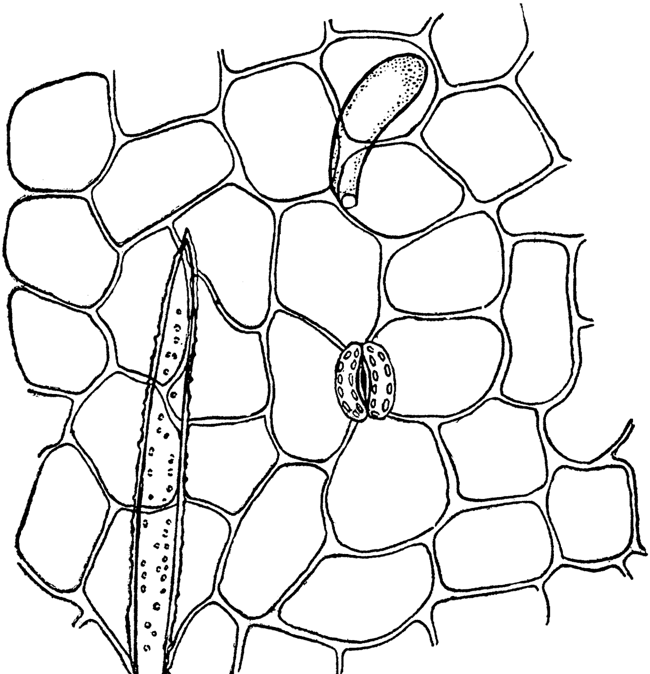
2. NORMAL PETAL, NEAR BASE, × 400.

The sepal of both normal and virescent *Oxalis stricta* is green, oblong, with smooth edges. The venation is practically parallel. The exterior surface of the sepal shows a number of hairs. distributed over the entire surface. They are of three kinds (fig. 3), the different kinds occurring with different frequency. Most numerous are the long and thick-walled unicellular hairs which occur from the base to the tip. At the



3. BACK OF SEPAL, × 400.

latter point there are so many of them as to form a small fringe. These hairs are appressed and identical with the appressed hairs on other portions of the plant. Less numerous are the very short, more or less pear-shaped, unicellular hairs Very unfrequently a thin-walled, one- or several-celled hair is met with. These hairs are identical with those which may be observed, with the naked eye, on the stem, etc., and which often give a woolly appearance to some portions of the plant. Stomata are quite frequent. Numerous crystals of calcium oxalate can be seen. The cells, which are longer than broad, possess smooth cell walls. The ridges, so marked in the cells of the epidermal layers of the petal, are entirely absent. The interior surface of the sepal shows as a rule no hairs, though occasionally one of either of the three



4 BACK OF VIRESCENT PETAL, × 400.

kinds just described may be met with. The stomata are less numerous.

The petal of *O. stricta viridiflora* is green in color, and obcordate, with an undulate margin. The distribution of the vascular bundles is in accord with the outline of the petal. The exterior surface shows a limited number of hairs. These are situated along the margin of the tip. The large unicellular thick-walled kind is most frequent. Next in frequency comes the small, unicellular thin-walled hair. Multicellular hairs are rare. The epidermal cells (fig. 4) entirely lack the projecting ridges of the cell walls of the epidermal layer in normal petals. While near the base the cells are longer than broad, near the tip the cells are more or less isodiametric. Often the upper surface of these cells forms blunt papillae. Stomata are more numerous than on the normal petal of *O. stricta.* On the inner surface of the petal of the variety, there are no hairs and the stomata are few.

Thus far then, the petal of *Oxalis stricta viridiflora* differs from the normal petal of *Oxalis stricta* in the following particulars, *i. e.*, color, width, distribution of vascular bundles, shape of the epidermal cells, absence of ridges in the latter, number of stomata, and in the possession of hairs of the unicellular, thin-walled type, as well as a slight increase in the total number of hairs. But the internal structure shows further differences. While the petal of *O. stricta* is but a few cells thick, that of the variety is much thicker, and the tissue is composed of several layers of cells much smaller than those of the epidermis. These small cells are filled with chlorophyll granules. Any attempt to demonstrate the presence of xanthin in the cells of the petals of the green-flowered variety was unsuccessful.

Though in many respects the petals of this virescent form approach the sepals in structure, they do not represent marked sepalody as it is presented in certain Onagraceae,* for example, while their shape, instead of approaching that of the sepals, deviates widely from it.

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* Hus, Henri. Over sepalodie van de kroonbladen van Oenothera-soorten. Avec un résumé en langue française. (Botanisch Jaarboek. Gent. 1004).

The flowers of normal *O. stricta* open widely on bright mornings and close at noon. The flowers of *O. stricta viridiflora* never open widely, but on the other hand are but little influenced by the amount of light. They open in the morning and never close, something very different from what happens in *O. stricta.* Here the petals close over the young fruit, and sooner or later become loosened at the base. Frequently they form a cap which is carried up on the tip of the growing fruit, where they may remain till maturity. In the variety *viridiflora,* however, the petals persist, in good condition, for a long time, often till the fruit is nearly ripe (plate 11). This agrees with the observations of others in similar cases.*

The fertility of the variety does not appear to have been impaired, since both in 1906 and 1907 seed could be gathered in large quantities. It is absolutely self-fertile, as will be shown later. An attempt to distinguish plants by relative lengths of stamens and styles yielded no satisfactory results.

When the plants of *Oxalis stricta viridiflora* were met with for the first time, it was thought that the green color of the petals was due merely to a passing virescence and that the green-petaled strain might perhaps be propagated in a vegetative manner. This, experience has shown us to be possible for frondescence not caused by parasites† such as is met with in the green rose and wheat-ear carnation. For this reason, in September, 1906, a few plants of the variety were transported to the Missouri Botanical Garden, where they were kept in pots in a cold frame over winter. The attempt met with but indifferent success. During October and November a few small, green-petaled flowers made their appearance. In the spring the single small plant which survived was transplanted to a frame and there produced a few flowers, all green. At no time was there material for purposes of vegetative propagation, and finally the plant died.

This was no great loss, since it was found that in the spring of 1907 a number of green-flowered specimens had again appeared in the old locality. Besides, the interest was centered in the seedlings obtained from a small amount of seed gathered in the fall of 1906 on green-petaled plants in Bellefontaine Cemetery. In the spring all seed was sown in sterilized soil. The seedlings which appeared were first transplanted to a flat, which was placed in the screenhouse.* Forty-four seedlings in all made their appearance. One of these died. The remaining 43 were transplanted just at the time when they commenced to flower. With one exception, all bore the green-petaled flowers. There was but one plant which bore yellow flowers. Already in its earliest stages it could be distinguished from the others by its darker, somewhat brownish foliage. How to account for this plant is difficult. Insufficient sterilization of the soil is a possibility which can safely be excluded. Numerous control experiments have proven this. Besides, had such been the case, seedlings of other plants might have been expected to make their appearance. There remain two possibilities. Either the plant is the result of a cross or the seed was accidentally mixed at the time of collection. At least another year will be needed to settle this question with any degree of certainty.

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* Masters, M. T. Vegetable Teratology. 241.

† De Vries, Hugo. Een epidemie van vergroeningen. (Botanisch Jaarboek. 8 : 66. 1896).

Engelmann, † in his classical treatise on plant teratology, distinguishes two classes of virescence. By virescence in the narrower sense he understands those cases where an organ, losing its color, becomes green though retaining its original form. Under frondescence, on the other hand, he classes those cases where organs, while retaining their position, acquire the character of leaves. To the latter phenomenon,

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* This screenhouse, composed of a wooden frame, into which panels of fine wire screen are fitted every spring, and which possesses a glass roof, I use for the purpose of excluding insects from those of my plants which do not readily lend themselves to protection from insect visits by means of parchment paper bags or portable screen-cages. It is especially useful in the cross-fertilization of very small flowers, where the operation is liable to be long and tedious. It allows the potted plant to be elevated to a convenient height and eliminates all danger of insect visits during the operation.

† Engelmann, G. De Antholysi Prodromus. 32. Frankfurt a. M. 1832. Reprinted in "The Botanical Works of the late George Engelmann."

Morren,* who goes into details, applies the term phyllomorphy. But Penzig† does not draw so sharp a line of distinction. Ordinarily there is no need for this, since evidently numerous cases exist where the two phenomena grade into each other, as evinced by Penzig's phraseology. Besides, where virescence in the stricter sense affects the entire flower, the result, *i. e.*, the non-production of seed, is the same. This was the case in the virescence of *Lonicera Periclymenum* mentioned by Morren, something which I also have been able to constatate during 1904, 1905 and 1906 on plants of *L. sempervirens* cultivated in the Missouri Botanical Garden. But it is a very different matter where virescence affects but a single circle of floral envelopes. The other organs appear to be in no way changed. The fertility of the flower is not impaired. The abnormality is transmitted to the offspring.

It would appear then that in *Oxalis stricta viridiflora* we have a variety, at once constant from seed, which differs from the species in but one character. This character chiefly finds expression in (1) the color of the petal, due to the presence of chlorophyll granules, and (2) the texture of the petal, due to an increase in the number of layers of cells. Thus far this variety does not seem to have spread in the neighborhood of the type locality. But in the vicinity of Belleville, Ill., not far from St. Louis, my father, Dr. M. P. Hus, during August, 1907, found three plants of what appeared to be O. *stricta* with white petals and white and green petals.‡ A microscopical examination confirmed the opinion that but little, if any, chlorophyll would be found in the white parts. The yellow chromoplasts were not entirely absent from all cells, but present in so small number as to be ineffective. This plant also will be taken into cultivation. Crossing experiments undertaken this year will, during the next, undoubtedly yield interesting results.

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* Morren, Ch. Les virescences distinctes des phyllomorphies et cas particulier d'une virescence de chèvrefeuille. (Bull. Acad. Roy. Belg. **17**^{2} : 125. 1850).

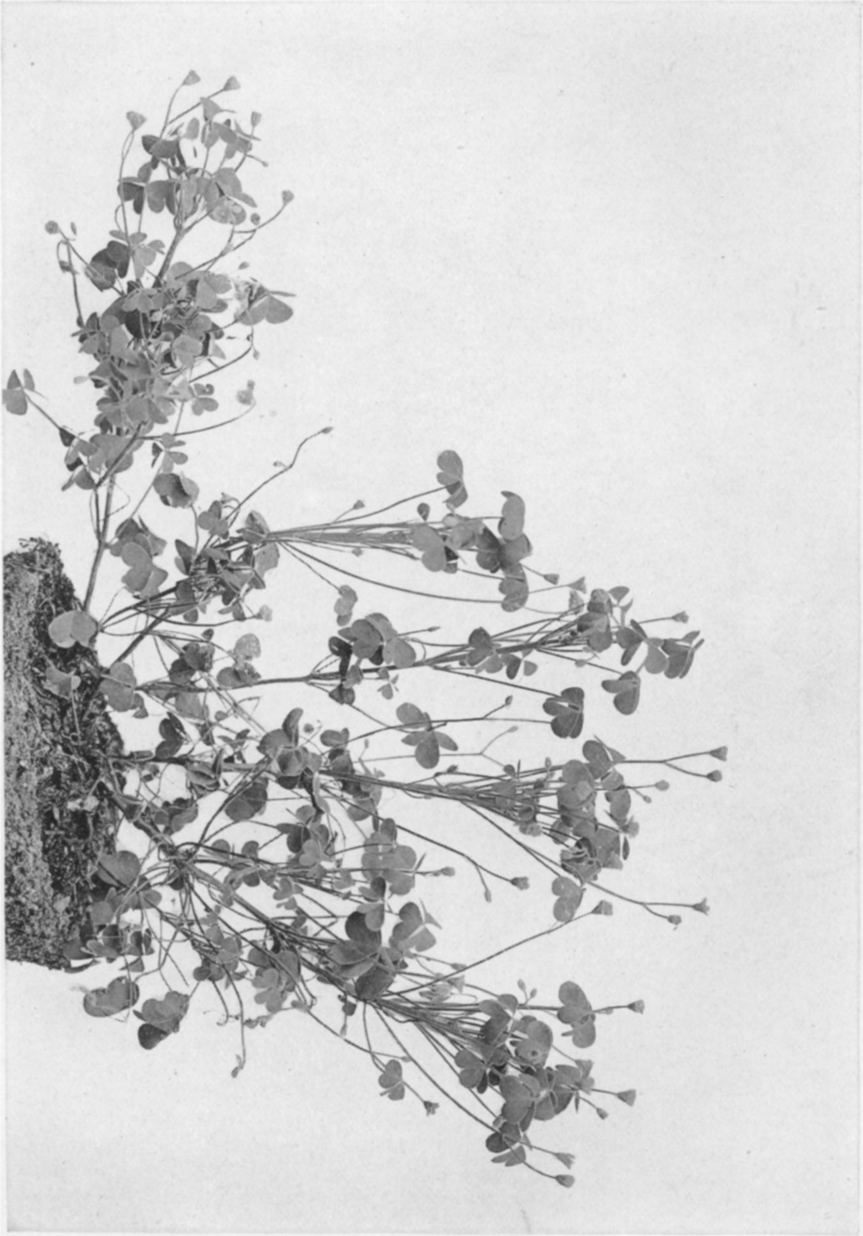
† Penzig, O. Pflanzen-Teratologie. **1** : xx. 1890.

‡ A white-flowered form of *O. violacea* is sometimes found.

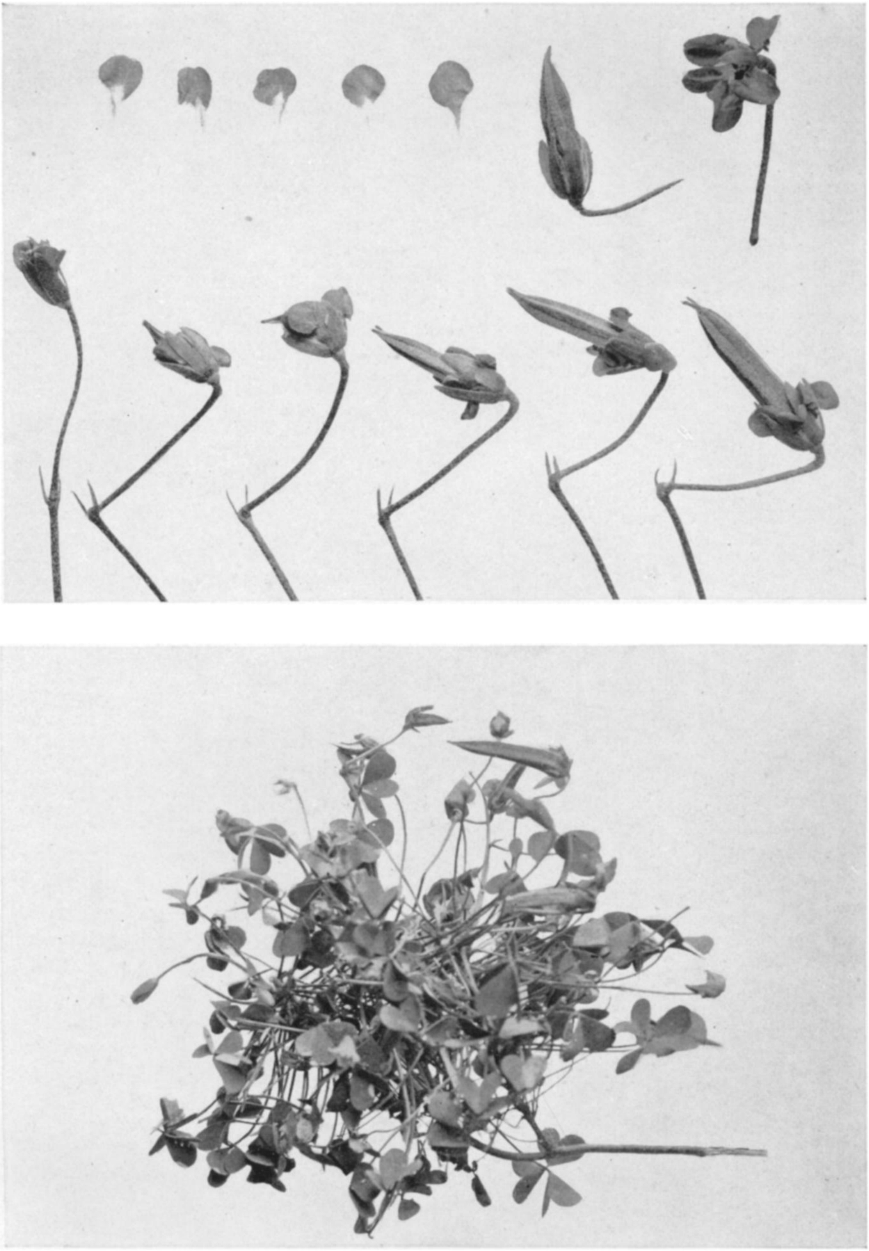
EXPLANATION OF PLATES.

PLATE 10.—*Oxalis stricta viridiflora.* Cultivated plant, × ½.

PLATE 11.—*Oxalis stricta viridiflora.* Above, parts of the flower and fruit, × 2. First are shown five petals, then a fruit from which the petals have been removed, followed by a flower which contained a pod of about the size of the one below it. This pod was cut out near the point of attachment. The five petals and some of the sepals are shown. The next row shows six stages in the development of the fruit. The one on the right is almost mature, but the petals are still present. Below, a fruiting plant collected in the original locality, × 1.



OXALIS STRICTA VIRIDIFLORA.



OXALIS STRICTA VIRIDIFLORA.